

## Achieving flexible and sustainable energy systems

**Skytte, Klaus**

*Publication date:*  
2018

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*

Skytte, K. (2018). Achieving flexible and sustainable energy systems [Sound/Visual production (digital)]. Future opportunities for Danish-Korean Clean Energy collaboration, Copenhagen, Denmark, 25/05/2018

## DTU Library

Technical Information Center of Denmark

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



# Achieving flexible and sustainable energy systems



**Flex4RES**  
Flexible Nordic Energy Systems

**Klaus Skytte**

[Klsk@dtu.dk](mailto:Klsk@dtu.dk)

Energy Economics and Regulation  
DTU Management Engineering , Denmark



# DTU Management Engineering

## Systems Analysis division

- **Energy Systems Analysis (ESY)**

- Global and regional energy system optimisation models (all sectors)
- Integration of intermittent renewables in energy systems
- GIS preprocessing tools
- Quantitative scenario analysis

- **Energy Economics and Regulation (EER)**

- Analyses of regulatory frameworks and market designs that facilitate the transition towards larger share of renewable energy in the energy system, energy savings, and climate change
- Policy analysis and economic assessment
- Economic and social aspects of wind integration, coupling of markets, and flexibility options
- Demand behaviour based on technical/economic or econometric models

- **Climate Change and Sustainable Development**

- Modelling of climate Change mitigation, renewable energy, and smart cities;
- Decision making tools for climate change impacts and adaptation

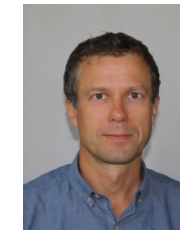
- **Transport Economics**



Poul Erik Morthorst



Kenneth Karlsson



Klaus Skytte



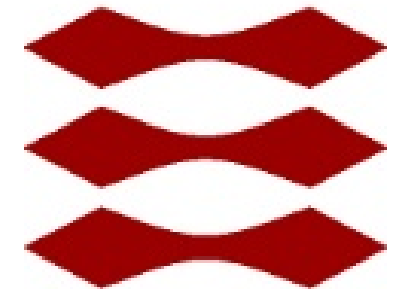
Simon Bolwig



Ninette Pilgaard

DTU Management Engineering  
Institut for Systemer, Produktion og Ledelse

DTU



Sister departments

**DTU Wind Energy**  
Department of Wind Energy

**DTU Energy**  
Department of Energy Conversion and Storage

**DTU Elektro**  
Institut for Elektroteknologi

# REPLI - DTU Renewable Energy Policy, Planning and Integration Advice

## *Scientific advice within energy*



### *Scientific advice*

An integral part of Danish universities' portfolio of activities

**1/5** of DTU's staff are involved with scientific advice

DTU is #2 in the world and #1 among the European universities in the category Energy Science and Engineering on the Academic Ranking of World Universities 2016 (Shanghai Jiao University)

We have the expertise and the infrastructure.

### *Goal*

The Sustainable Development Goal nr. 7.



### *Means*

Collaboration between universities, companies, authorities and international organizations



better technology and analysis methods within the energy sector.



# Why advice on sustainable energy from DTU?

REPLI provides research based advisory services and capacity building within integration of intermittent renewable energy sources.

Our advisory services range from technology choices to policy advice and implementation.



Technical University of Denmark

Departments and Cent

## REPLI

ADVISORY SERVICES

COMPETENCIES

ABOUT

CONTACT

Energy Policy & Planning

Renewable Energy Integration

Variable Renewables

ADVISORY SERVICES FROM TECHNICAL... > Advisory Services

SHARE



### No one-size-fits-all solutions

REPLI offers no one-size-fits-all solutions. The challenges in growing cities, rural areas and isolated islands are extremely diverse when it comes to securing clean and cheap energy without affecting our climate system.

In each case REPLI takes the actual local situation, available resources, existing infrastructure and local competencies as a starting point for utilisation and integration of clean energy sources such as solar, wind and thermal energy.

### Among our clients are



### Advisory Services

We offer international advisory services and capacity building, covering the entire value chain, from mapping of energy resources, technology solutions and systems integration to policy advice and implementation. We bring together the relevant expert and specialist competencies necessary to provide reliable, affordable and sustainable solutions to our clients.

Our clients include governments, development banks and international organisations, and we often work in collaboration and in consortia with private sector firms and organisations.

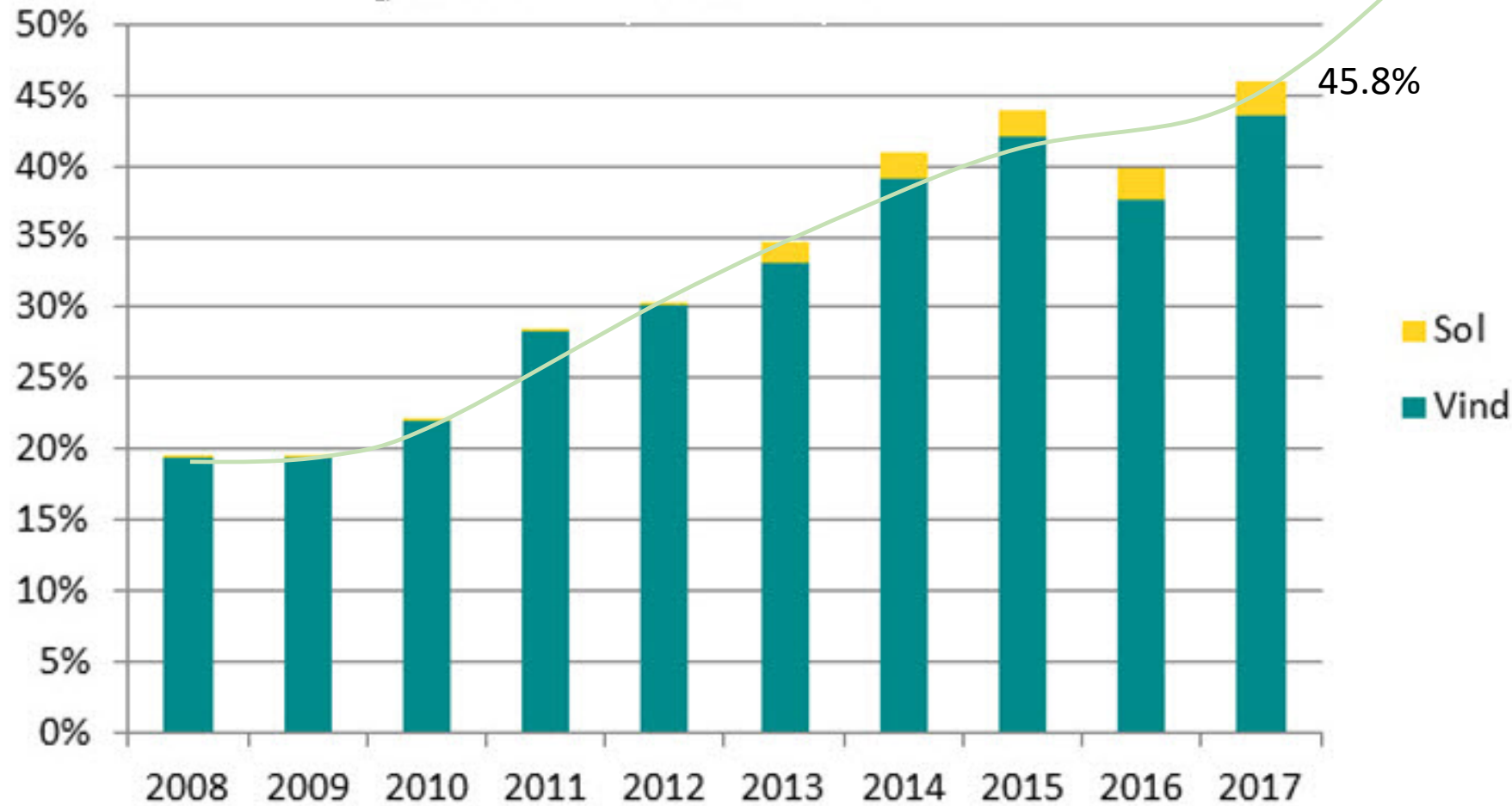
About 20% of DTU's 5,800 employees work with research-based advisory services, directed towards public organisations and the activity generates an annual turnover of approximately DKK 1 billion (USD 150 million).

DTU's research-based advisory services also include close collaboration with industrial stakeholders, such as providing advice related to front-end innovation, deployment of new technologies and test and demonstration facilities.

Updated by Leif Sønderberg Petersen

# The Kingdom of the Winds

## Wind share in Danish annual electricity consumption



23 December 2017:  
1 hour with 139%

25 December 2017:  
1 day with average of 109%

### Political target 2050:

The total energy supply  
based on renewable energy  
incl. heat, gas, transport, industry, etc.

### District heating:

50% share of total heat supply, with 69% CHP and <1% P2H





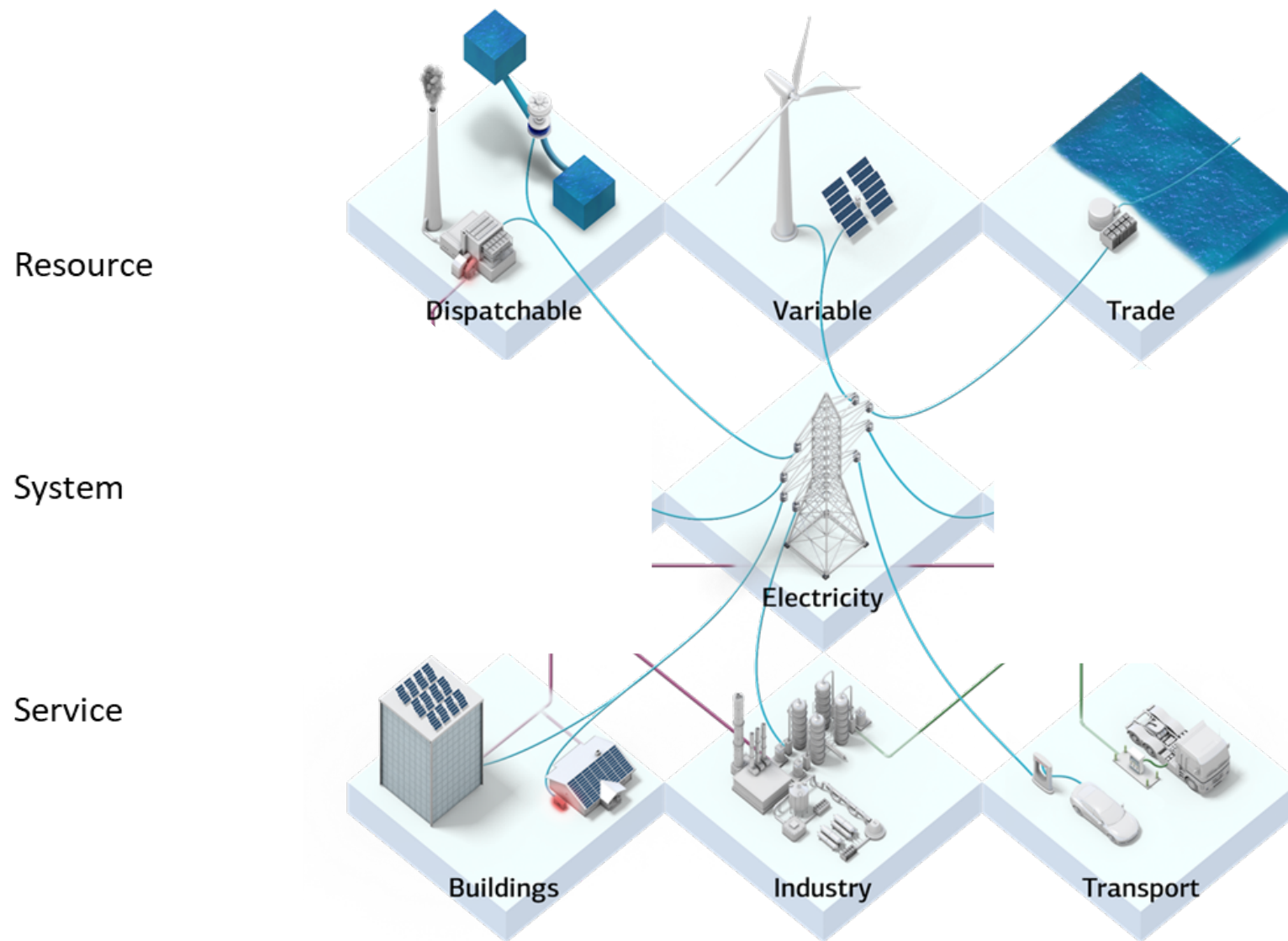


# Flexibility Resources

Finding ramping capabilities

DTU Management Engineering  
Institut for Systemer, Produktion og Ledelse

---



Supply flexibility

Demand responds

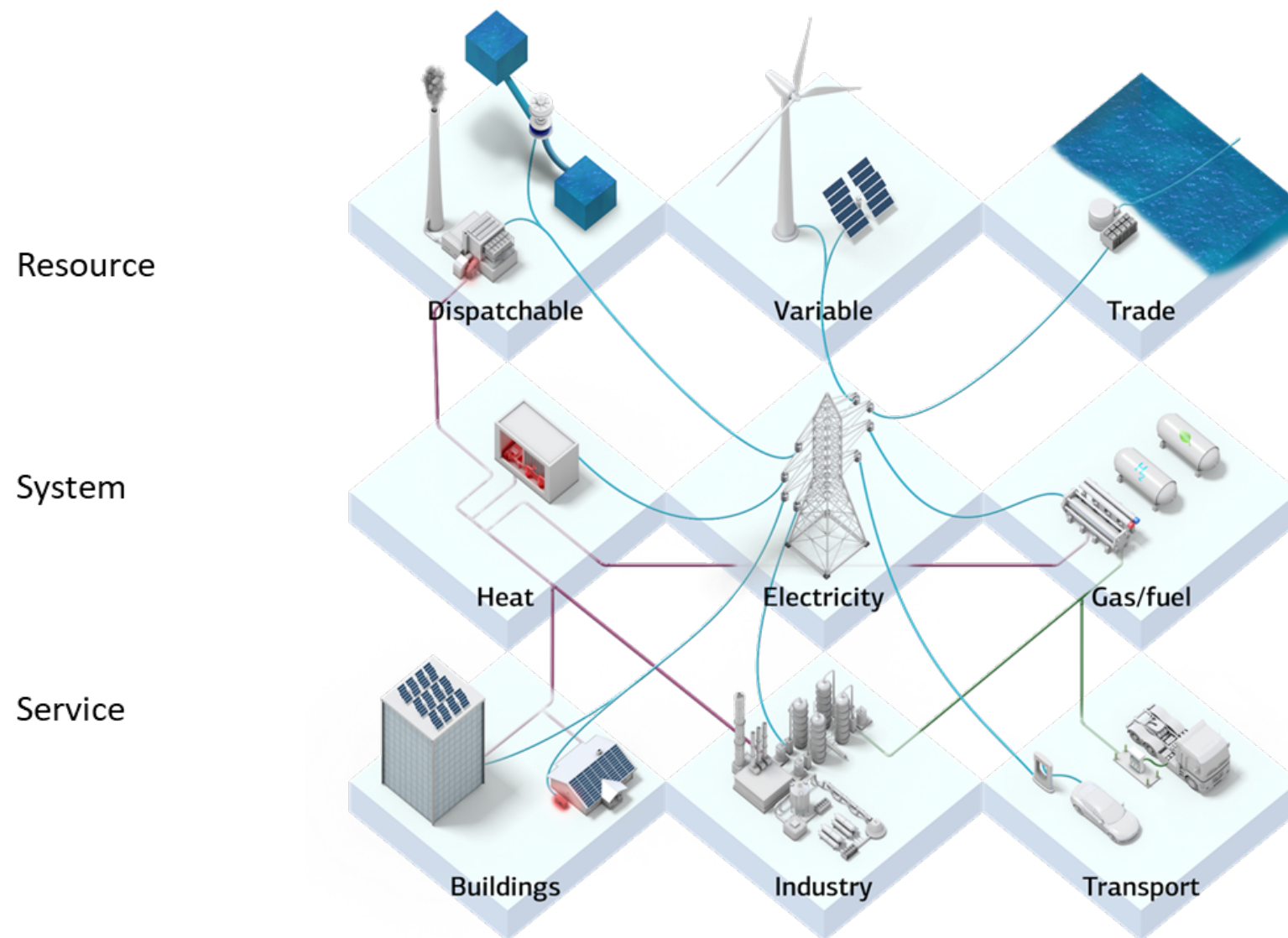


# Flexibility Resources

Finding ramping capabilities

DTU Management Engineering  
Institut for Systemer, Produktion og Ledelse

---



Supply flexibility

Sector coupling/  
Electrification

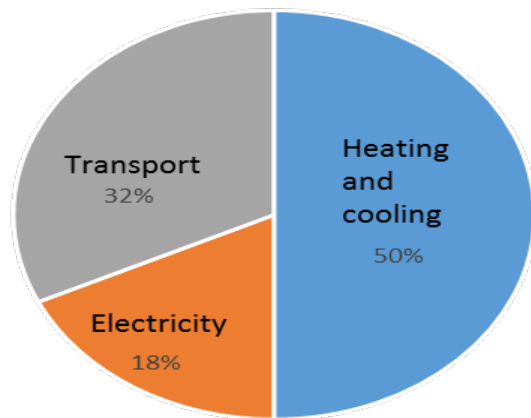
Demand responds





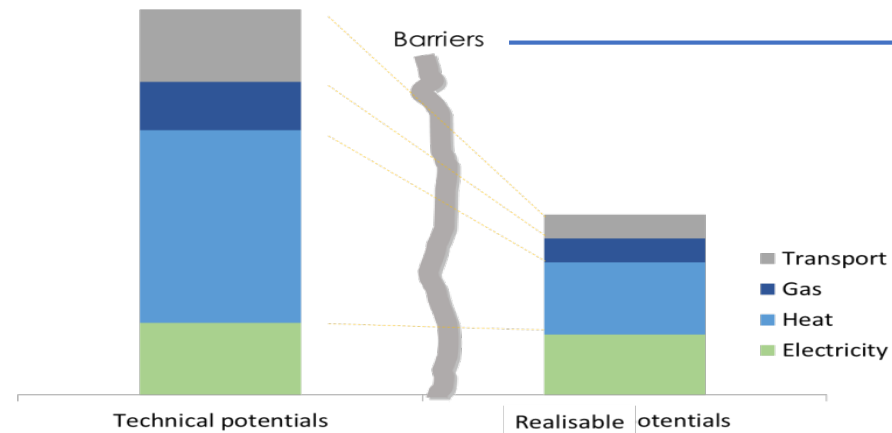
# Sector coupling

## Electrification as source of flexibility



Distribution of EU energy consumption  
(Source: EU Heating and Cooling strategy)

### From technical to realisable potentials



### Framework conditions

- Market design
- Direct regulation
- Fiscal policies
- Support schemes
- Grid regulation

Large flexibility potentials in electrification  
of the energy sectors

Hindered by regulatory barriers

Remove barriers

# Better Policies Accelerate Clean Energy Transition

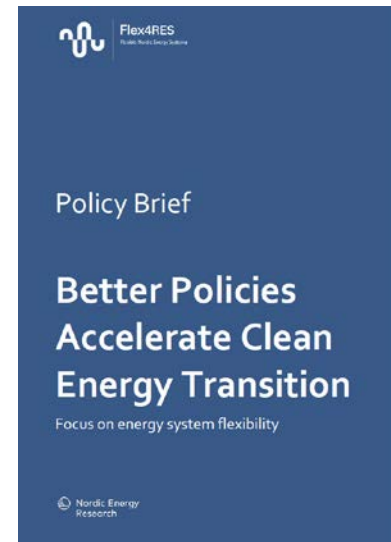
DTU Management Engineering  
Institut for Systemer, Produktion og Ledelse

*Insufficient market signals and uneven frameworks for different renewable energy resources limit flexibility*

*Revise tariffs, taxation, and subsidies in Nordic-Baltic countries to increase flexibility*

Seven policy recommendations:

- R1: Create a level playing field for all RES across sectors through consistent fiscal policies;**
- R2: Implement electricity grid tariffs which allow market signals for flexibility to reach the end-users;**
- R3: Dynamic taxation of electricity (e.g. restructuring levies and taxes);**
- R4: Encourage VRE operators to act flexibly using short-term market-based incentives;**
- R5: Abolish RES support during negative price periods;**
- R6: Enhance electrification by removing the limitations on using electricity for heating;**
- R7: Tackle investment risks in flexible individual heating through new financing and private ownership models.**







## Unlocking flexible and sustainable energy systems

Both technology deployment and regulatory changes

Coherent changes in market designs, regulatory framework condition, and coupling of markets

Make the sector coupling/electrification as flexible as possible

- Remove barriers
- Improve the business case for flexible power-to-heat/gas technologies
- Increase market integration and the value of VRE



[www.Flex4RES.org](http://www.Flex4RES.org)

[www.repli.dtu.dk](http://www.repli.dtu.dk)

[www.sys.man.dtu.dk](http://www.sys.man.dtu.dk)